LOW-IMPACT DEVELOPMENT MANUAL
FOR DUVAL COUNTY

Prepared by:

Subdivision Standards Policy Advisory Committee
Low Impact Development Subcommittee

City of Jacksonville

Date, 2010

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ACKNOWLEDGEMENTS

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DISCLAIMER

While many developments share common elements, each is unique. The information in this manual is intended only as a starting point and guidance for the reader. It should be used only in conjunction with careful consideration of applicable laws, rules, codes, ordinances, standards and the like including, without limitation, the Americans with Disabilities Act ("laws") and interpretations of laws in effect at the time of a specific development. This manual does not alter in any way the laws applicable to the planning, design, construction, operations and maintenance of building and development projects in Duval County.

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I. PURPOSE OF MANUAL

This manual provides technical guidance and design specifications on Low Impact Development stormwater management practices for application to projects in Duval County, Florida. It is not to be used in place of - but rather as a supplement to - Duval County and St Johns River Water Management District (SJRWMD) stormwater and surface water management guidance documents regarding local design criteria and LID applicability. For all projects, check with local officials and other agencies to determine additional restrictions and/or surface water or watershed requirements that may apply.

II. BACKGROUND

Low Impact Development (LID) is a stormwater management approach that uses a suite of hydrologic controls (structural and non-structural) distributed throughout the site and integrated as a treatment train (i.e., in series) to replicate the natural hydrologic functioning of the predevelopment landscape. The fundamental goal of applying LID concepts, design, and practice is to improve the overall effectiveness and efficiency of stormwater management relative to conventional systems, reducing total and peak runoff volumes and improving the quality of waters discharged from the site.

A site-specific suite of LID integrated management practices can be applied to most if not all development scenarios in Duval County. Regardless of the project context, LID requires consideration of the following core site planning and design objectives:

1. Preserve or conserve existing site features and assets that facilitate predevelopment hydrologic function.
2. Minimize generation of runoff from impervious surfaces (i.e., use peak and total volume controls) and contamination (i.e., use load controls) as close to the source as possible.
3. Promote distributed retention, detention, treatment, and infiltration of runoff.
4. Capture and reuse stormwater on site.
5. Minimize site disturbance and compaction of soils through low impact clearing, grading, and construction measures.

The toolbox of LID integrated management practices to facilitate these objectives is extensive, including structural and non-structural designs, and LID projects are most effective when applied in a *treatment train,* or series of complementary stormwater management tools and techniques. In addition, an LID stormwater management approach is most effective when sites are evaluated for LID compatibility as early as possible in the planning process and site considerations are considered carefully in the design and construction of each LID practice. This manual supports Duval County's goal of applying the LID concept and design where feasible to enhance existing stormwater management measures and reduce the adverse impacts of land development projects on the County's natural resources.

III. INTENDED USERS

This LID Manual is intended for use primarily by professionals engaged in the planning, design, construction, operations, and maintenance of building and development projects in Duval County. These potential users include but are not limited to stormwater design engineers, stormwater utility staff, natural resource managers, planning officials and administrators, building officials, architects, landscape architects, site design specialists, and landscape operations and maintenance professionals.

IV. DEFINITIONS

Bioretention: Shallow landscape depressions with soils, mulch, and planted vegetation intended to capture, treat, and infiltrate stormwater runoff.

Bioretention Cell: An isolated landscape depression with an inlet only and an overflow pipe or “spillway” included only for extreme flow events. Storage volume recovery of the bioretention cell is only through infiltration or evapotranspiration. Other terms often applied include *rain garden*, *dry retention* and *planting/tree well.*

Detention with Biofiltration: A landscaped depression area with a separate inlet and outlet (underdrain). Depressions are often linear and may be connected in series. Storage volume recovery of the depression is through an underdrain system. Other terms often applied to similar practices include *biodetention, bioswales*, and *vegetated swale*. See also *Bioretention, In-Line*

Bioretention, Off-Line: Landscaped depression areas connected by a common inlet and outlet to another conveyance system. Storage volume recovery of the basin is only through infiltration or evapotranspiration. Other terms often applied include *rain garden, dry retention*, and *planting/tree well*. See also *Bioretention Cell.*

Buffer Wetland: An area adjacent to a wetland or other habitat that protects the habitat from the adverse impacts of development.

Buffer Landscape: An area that reduces potential incompatibility of adjacent land uses, provides roadway beautification, conserves natural resources and provides open space. It includes project boundary buffers and street buffers.

Common Land or Area: Any parcel of land owned by or used jointly for mutual benefit of more than one party (such as open space or recreational areas). A condominium association, homeowners association, or similar organization shall be construed as being more than “one party” for the purposes of this definition.

Conservation or Conserve: To set aside areas of native habitats in perpetuity, other than preserves, and managed in accordance with the Principles for Evaluating Development Proposals in Native Habitats in the Environment Chapter of the Comprehensive Plan. These areas may be used to fulfill open space or other requirements.

Density: The number of residential dwelling units permitted per gross acre of land as determined by the Duval County Zoning regulations.

Detention with Biofiltration: Shallow landscape depressions with soils, mulch, planted vegetation, and underdrains used as structural stormwater controls to capture and treat stormwater runoff. See also *Bioretention, In-Line.*

Development: A subdivision of land or a site and development as defined by these regulations, a residential mobile home park, and any other construction whether residential, commercial, industrial, office, professional, institution, or recreational except a one- or two-family dwelling on an individual lot or lots.

Easement: Any strip of land crated by a subdivider for public or private utilities, drainage, sanitation, or other specified uses having limitations, the title to which shall remain in the name of the property owner, subject to the right or use designated in the reservation of the servitude.

Equivalent Dwelling Unit (EDU): The use of building space in such a manner as to have the potential of using 250 gallons of potable water per day or generating 200 gallons of sewage per day.

Exotic: A species introduced to Florida, purposefully or accidentally, from a natural range outside of Florida.

Floodplain: Any land area inundated by flood events of various recurrence intervals as defined by the latest Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), Duval County Basin Studies, or whichever data are, in the determination of the County, more accurate.

Greenroof: A roof with vegetation planted on it.

Greenroof Stormwater Treatment System: A vegetated roof with a cistern that can be used for stormwater pollution control, volume reduction, and peak flow reduction.

Invasive Exotic: An exotic species that not only has naturalized but is expanding its range into natural areas and disrupting naturally occurring Florida plant and animal communities.

Land: Includes all ground surfaces, water, floodplains and wetlands.

Landscape Plant: Any native or exotic tree, shrub, or groundcover (excluding Turf).

Littoral Zone: That portion of any lake, borrow pit, or pond measured from seasonal high water elevation in water bodies where water elevation is not controlled by structures, or from the overflow elevation in water bodies where water elevation is controlled by structures, to a depth of 3 feet. Littoral zones also include those areas in salt or brackish water (Gulf, bay, estuary) from the mean high water elevation to a depth of 3 feet.

Lot: Includes tract or parcel and means the least fractional part of subdivided lands having limited fixed boundaries and an assigned number, letter, or other name through which it may be identified.

Lot Drainage Plan: A plan for the discharge of stormwater from residential lots.

Low Impact Development: An environmentally responsible approach to developing land and managing stormwater runoff that incorporates environmentally sound technology and sustainable design techniques to address adverse impacts of urbanization and protect aquatic resources, water quality, and the natural pre-development hydrology. To mimic pre-development conditions, the design techniques infiltrate, filter, store, evaporate, treat, and detain runoff close to its source.

Low Maintenance Sod Alternative: Florida native, non-invasive, drought-tolerant, erosion control plantings consisting of grasses, vines, shrubs, and trees or median and curb treatments as approved by the County Engineer or designee.

Mitigation Areas: Areas that are created, restored, enhanced, or preserved and maintained to compensate for habitat loss.

Native: A species whose natural range included Florida at the time of European contact

Native Habitats: Those areas of Sarasota County described in the Habitat Inventory and Analysis section of the Comprehensive Plan Environment Chapter, with the exception of Intensive Agricultural Areas and Developed Features.

Naturalized Exotic: An exotic species that sustains itself outside cultivation (it is still exotic; it has not "become" native).

Nuisance: A species that threatens native species' abundance or diversity or the stability of an ecosystem or ecosystem process by its aggressive growth habit.

Pervious Pavements: Structural stormwater controls that capture and infiltrate part or all of the water quality volume from contributing areas.

Plan, Conceptual: A general graphic and informational representation of a design proposal for a development phase or the entirety indicating existing and proposed uses, contours, lots, blocks, streets, structures, and other physical aspects of the land proposed for development.

Plan, Site: A scaled graphic and informational representation of a specific design solution for a development phase or the entirety on which is shown an area location map; existing and proposed topography, streams, right-of-way, easements, structures, wooded areas, and water bodies; provisions for ingress and egress; off-street parking, loading, refuse, and service areas; necessary facilities and utilities; required yards, open spaces, and recreational uses and facilities; proposed landscaping, fencing, screening, and buffering and provision for trees protected or required by County regulations; proposed signs and lighting; and any other information that may be necessary or reasonably required.

Plan, Water Resource Management: A site-specific, comprehensive management plan prepared by a qualified environmental professional that detail goals, actions, and BMPs used by the development to minimize any adverse environmental impacts. The plan shall include but is not limited to the following components: Water Resource Management, including sources, uses, conservation, and water quality protection; Stormwater Management; Wastewater Treatment and Waste Management; Solid and Hazardous Waste Management; Chemical Waste Management (pesticides, oil, diesel, grease, etc.) and spills protocols; Integrated Pest Management; Fertilizer Management; Soils Management; Irrigation Resources and Systems Management; and Groundwater Management.

Pollution Control Measures: Temporary or permanent management strategies that are applied to protect air and water quality by preventing or minimizing the pollution of the air, surface water, and groundwater.

Preservation or Preserve: To set aside in perpetuity areas of native habitat that must not be disturbed, in accordance with the Principles for Evaluating Development Proposals in Native Habitats in the Environment Chapter of the Comprehensive Plan.

Preservation or Preserve Trees: Those trees to be preserved as specified in a County Tree Removal and Protection permit pursuant to Chapter 54, Article XVIII. Tree Protection.

Pretreatment: Stormwater volume and/or water quality controls applied upstream from or before capture, storage, treatment, infiltration, and/or reuse by a subsequent stormwater management practice in a treatment train.

Redevelopment: The construction, installation, replacement, reconstruction, alteration, or other material change of a structure, impervious surface, drainage facility or part thereof on a previously developed site requiring a development order or permit.

Soils: Defined in the current United States Department of Agriculture Soil Survey of Duval County, Florida.

Stormwater Management System: The appurtenances, facilities, and designed features of the property, which collect, convey, channel, hold, treat, detain, or divert, or otherwise manage stormwater runoff.

Stormwater Reuse System: Combination of a specified reuse volume and rate of use intended to achieve a yearly average reduction in discharge mass; typically including a surface detention pond or other methods of storage.

Stormwater Utility: A means for “funding of a stormwater management program by assessing the cost of the program to the beneficiaries based on their relative contribution to its need. It is operated as a typical utility which bills services regularly, similar to water and wastewater services.”

Survey: A survey as defined in the Minimum Technical Standards for Surveying, Chapter 61617, Florida Administrative Code.

Treatment Train: An integrated series of stormwater management practices, each of which provides incremental stormwater attenuation and/or treatment benefits.

Turf: A piece of grass-covered soil held together by the roots of the grass.

Undesirable Vegetation: Exotic, naturalized exotic, invasive exotic, and nuisance plant species as defined in this section and listed in Section F of the Environmental Technical Manual.

Waterbody: A natural body of water including rivers, lakes, streams, springs, ponds, and all other natural bodies of water including tidal, fresh, brackish, and saline.

Water Quality: A desired standard or degree of excellence defined by the physical, chemical, biological, and aesthetic characteristics of water in an attempt to preserve or attain its purest state of having no contaminants.

Water Quality Degradation: The natural and/or anthropogenic introduction of sediments and/or contaminants into ground or surface water that would result in a violation of State Water Quality Standards or that would prevent those waters from meeting designated present and future most beneficial uses.

Water Quality Monitoring Program: A comprehensive sampling program designed to assess the surface water quality of a specific body or bodies of water that includes, but is not limited to, the flowing components: Physical and chemical parameters; analytical methods; standard operating procedures (SOPs); sampling locations; frequency and duration of sampling; and data analysis and reporting.

Water Quality Standards: Standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, the Florida anti-degradation policy, and the moderating provisions contained in Rule 62-4, F.A.C., adopted pursuant to Chapter 403, F.S. for surface water and Rule 62-520-400, F.A.C. for groundwater.

Wetland Buffer: An area adjacent to a wetland that protects the wetland from the adverse impacts of development.

Wetlands: Those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances do support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

V. Duval County Hydrology

VI. Urbanization and water quality standards - Stormwater Rule consistency / TMDL-BMAP

VII. Duval County Standards Supporting LID

VIII. Site Assessment

OVERVIEW

Evaluating Your Site and Planning for LID

To achieve optimal performance of LID systems, project planners and engineers must adopt a comprehensive and iterative approach to site evaluation, planning and design, and monitoring and feedback. This chapter provides guidance on the process of assessing a site and planning for LID so that opportunities to protect water resources are maximized and adverse development impacts are minimized.

Site choice is the first decision affecting the success of LID applications to any project. When the project location is not predetermined, planners are encouraged to consider compatibility with LID principles and practices in their site selection, an approach that complements and/or satisfies Duval County's development standards and stormwater management requirements. The County's Land Development Regulations, Article I Sec. 74-4, require development projects to provide "adequate stormwater management [so as] to reduce the impact of flooding to a minimum" and "protection of Sarasota County's natural systems and scenic resources, including the quality of air and both surface and groundwaters and the preservation of their ecological integrity." Given that LID principles aim to reduce total and peak volumes of stormwater runoff, thereby reducing pollutant loading to receiving waters, applying them to a development project – from site selection to long-term operations and maintenance – can help ensure that these County land-development standards are achieved.

Rather than focusing solely on treatment of stormwater runoff once it has been generated from a site, LID relies primarily on source controls and spatially distributed practices and systems that complement centralized, structured stormwater controls. Preservation of the predevelopment hydrologic signature of a site to promote management of stormwater runoff volumes and quality at the source, integrated with a series of on-site treatment practices, reduces the demand on centralized stormwater treatment systems. This is typically referred to as an LID "treatment train" approach to stormwater management. While conventional stormwater design typically involves constructing a single retention or detention pond to meet volume storage and pollutant control requirements for each basin, treatment-train design involves constructing multiple practices in series, where each individual practice provides incremental benefits that collectively achieve storage and pollution-control requirements. Project planners and engineers are encouraged to evaluate and design sites with a holistic perspective and in a fashion that is consistent with the treatment-train approach.

Fundamental LID principles such as those listed below should be considered in the development planning and design process:

1. Preserve or conserve site features and assets that facilitate predevelopment hydrologic function.
2. Minimize generation of runoff from impervious surfaces (i.e., use peak and total volume controls).
3. Minimize runoff contamination (i.e., use load controls) as close to the source as possible.
4. Promote distributed retention, detention, treatment, and infiltration of runoff.
5. Capture and reuse stormwater on site.
6. Minimize site disturbance and compaction of soils through low-impact clearing, grading, and construction measures.

This chapter provides examples of specific LID practices supporting these principles in its overview of the site-assessment and planning processes. It does not, however, address volume storage and water quality credits to be provided for implementing such practices. Such credits are to be determined by the County and St. Johns River Water Management District.

SITE ASSESSMENT

In most development projects, stormwater systems are designed to attenuate and treat altered hydrologic conditions that result from implementing a master development plan. Plans for new development typically require the following:

- Clearing onsite vegetation.
- Disturbing and compacting native or parent soils.
- Importing and grading fill material to establish the base and drainage contours.
- Constructing infrastructure to facilitate drainage away from the site.
- Introducing new landscapes that require nutrient and water inputs above predevelopment conditions to thrive.

Rather than fitting the stormwater system into the predetermined site plan, LID encourages an alternative design approach that integrates existing site features that facilitate natural hydrologic functions into the master plan. LID systems are designed to use and enhance predevelopment hydrologic, soil, and landscape conditions that promote on-site interception, capture, storage, treatment, and infiltration of stormwater. Site assessment, the first step in implementing this type of LID approach to stormwater management, involves careful consideration of the project's intent and thorough evaluation, documentation, and analysis of pre-development site conditions.

IX. Defining Project Intent

The type of development being planned, the expected uses, and the anticipated users of a site all have implications for effectively integrating LID features into the site, so these factors should be identified and documented early on in any project. Consider the following questions regarding the project's fundamental intent:

1. Is the project new or greenfield development, redevelopment or infill, or retrofit of an existing site?

2. Is the property planned (and zoned) for residential, commercial, industrial, or public use?
3. What local standards and/or programs offer incentives for and/or discourage implementation of certain LID practices?
4. Who are the anticipated users of the site (primary and secondary), and what are the project planners' expectations of how they will use the site?

An LID approach is compatible with all types of development; however, the suite of LID practices most appropriate for the project can vary significantly from one site to the next depending on the answers to the questions above. The list of practices that can be applied to new development of a relatively undisturbed site is usually extensive, ranging from opportunities to preserve tree canopy and natural depressions in the landscape to flexibility in sizing and location of stormwater ponds to allow for efficient capture and reuse of stormwater. Potential practices appropriate for retrofit applications, on the other hand, might be limited in number because of existing site constraints yet can be extensive in terms of the potential design scenarios for practices that are appropriate. Zoning requirements for different land-use categories may support the construction of certain LID practices and limit or prohibit others.

Those who will be using the site and the manner in which they will be using it also can influence the appropriateness and effectiveness of LID systems. Stormwater systems in residential applications, for example, are typically exposed to and can often be accessed physically by homeowners, so it is important that LID applications not only function as stormwater quantity and quality measures, but also that they are perceived as functional community amenities rather than nuisances or hazards.

X. Evaluating Baseline Conditions

When evaluating a site for the feasibility of integrating LID practices, the project planner and/or engineer must conduct a thorough analysis of baseline conditions. For this manual, baseline conditions are site features – including both assets and constraints – in their predevelopment state, or as they currently exist on the site. For new development projects, this baseline might closely resemble a natural or native landscape whereas for redevelopment it is likely to be altered significantly from natural or native conditions. In this phase of the project, the planner or design engineer should identify, understand, and document site conditions that facilitate rainfall interception, capture, storage, evaporation, transpiration, infiltration, treatment, and reuse. It is also important to note site features that restrict these natural hydrologic processes and to consider options for mitigating degraded conditions.

One way to begin this evaluation is to conceptually trace the path of rainfall as it moves within and through the site, considering, for example, the following types of questions:

- What natural features (tree canopy, vegetation, etc.) intercept and/or capture rain as it falls on the site and return portions of it to the atmosphere via evaporation and/or transpiration?

- What is the topography of the site and does it promote stormwater drainage away from the site or capture and infiltration of stormwater on site?

- What are the hydrologic soil groups (as classified by the Duval County Soil Survey) and distributions on site, and to what extent do they promote infiltration of rainfall (i.e., what are their infiltration rates)?

- Where and to what extent have soils been disturbed and/or compacted, reducing infiltration rates and promoting runoff generation?

- What is the elevation of the seasonal high water table throughout the site?

- Do critical and sensitive areas (wetlands, riparian areas, etc.) that provide capture, uptake, and filtering of pollutants exist on site and have they been protected or disturbed?

- What physical structures (buildings, parking lots, etc.) intercept rainfall and convey it as stormwater to other areas of the site and/or away from the site?

- What pervious surfaces (natural and structural) allow stormwater to infiltrate to parent soils?

- What impervious surfaces (natural and structural) prevent infiltration of stormwater and promote runoff?

- What engineered stormwater treatment systems exist on site and could they be enhanced or retrofitted to improve performance?

The collective opportunities and constraints posed by pre-development baseline site conditions will directly influence the final suite of LID practices most appropriate for a site. Planners and design engineers should assemble any available data and analyses that improve their understanding of baseline conditions and, when possible, hire licensed professionals to conduct additional surveys and/or inventories to fill important information gaps. Recommended data sets and analyses to gather for the site and surrounding areas include but are not limited to the following:

- Aerial photographs
- Road and utility surveys
- Topographic and drainage maps
- Flood plain and wetland maps
- Riparian zone/stream buffer maps
- Duval County Soil Survey
- Tree and vegetation surveys
- Rainfall data
- Hydrologic analyses

With these data planners and design engineers can identify key site opportunities and constraints to LID, including those that affect the ability of the LID systems to control stormwater quantity and quality at the source, infiltrate stormwater on site, function effectively as a treatment train, and capture and store stormwater for reuse.

XI. Site Planning and Design

Site planning for LID stormwater management is similar to planning for conventional stormwater management in that it applies structural engineered designs to meet stormwater quantity and quality criteria. LID site planning differs, however, in that it extends well beyond structural stormwater controls to include guidance on the fundamental design of a development; methods for protecting water quality and minimizing runoff generation at the source; practices that use physical, biological, and geochemical processes for stormwater treatment; and innovative stormwater reuse options. Most if not all LID practices provide multiple stormwater, environmental, and aesthetic benefits, but it is useful to consider the entire suite of practices that might be applied in terms of their relationship to the five fundamental LID principles discussed in this manual:

1. Preserve existing site assets.
2. Minimize and control runoff generation at the source.
3. Promote infiltration.
4. Promote stormwater reuse.
5. Minimize site disturbance.

XII. Preserving site assets

Planning for an LID project requires design that capitalizes on the beneficial features, or assets, of a site. A thorough inventory and composite analysis of site features helps the project planner identify design options for conservation, preservation, protection, and enhancement of areas that promote LID function. These beneficial features include the following:

- Tree canopy and “grand trees.”
- Native species of vegetation.
- Natural landscape depressions distributed throughout the site.
- Native soils that have not been compacted or disturbed.
- Stream buffers or riparian zones.

Careful management of these assets not only protects critical water resources, but can also reduce or eliminate certain costs of site development, including those for clearing vegetation, site grading, and erosion control.

XIII. Minimizing and Controlling Runoff Generation at the Source

Conventional development practices modify natural site drainage pathways by introducing a network of impervious surfaces (rooftops, driveways, sidewalks, roads, and gutters) that route stormwater away from the site or to stormwater treatment basins. While this process is very efficient at controlling runoff, it alters the hydrologic signature of the site significantly, increasing peak volumes and rates of runoff while conveying pollutants away from the site. Alternatively, LID emphasizes minimizing and controlling runoff generation at the source and facilitating onsite infiltration by applying practices that preserve pervious surfaces, limit the total area of impervious surfaces introduced, and disconnect impervious surfaces. Source-control design strategies, whether applied to new residential, commercial, or industrial development, are valuable not only for achieving stormwater quantity and quality targets, but also for reducing site preparation and infrastructure costs. Among the key LID site-design practices that promote volume control and water quality protection at the source (subject to zoning code requirements or restrictions) are the following:

- Preserving mature tree canopy, “grand trees,” and understory vegetation.
- Clustering homes, buildings, and other structures on smaller lots.
- Constructing greenroof stormwater treatment systems (Chapter 3.4).
- Minimizing impervious areas.
- Minimizing directly connected impervious areas (DCIA).
- Using shared driveways in residential applications.
- Using narrow roads with a pervious shoulder and/or right of way.
- Using road layout that minimizes linear impervious area.
- Using alternative parking lot design that minimizes total impervious area.
- Landscape designing that minimizes turf or landscape plants with high nutrient and water requirements.
- Landscape designing that maximizes preservation of existing native vegetation and introduces new vegetation that is appropriate for site conditions (e.g., Florida-friendly landscaping).
- Irrigating for establishment only, or use of smart water-application technologies, such as soil moisture sensors, that maximize irrigation efficiency.

XIV. Promoting Infiltration

Many LID strategies that reduce generation of stormwater at the source do so by preserving and promoting opportunities for infiltration on site. While potential stormwater infiltration capacity and rates are constrained by baseline conditions such as SHWT and soil types, infiltration dependent LID practices can be designed to perform effectively as part of a treatment train under most site conditions in Duval County. Optimal areas for location of infiltration-dependent stormwater practices (i.e., those with the highest infiltration rates) should be identified during the site-assessment phase of development. Specific LID practices that preserve or enhance infiltration function throughout the catchment basin include the following:

- Retaining pervious surface areas.
- Using biodetention (Chapter 3.1) and bioretention applications.
- Using pervious pavements (Chapter 3.2) for parking lots and residential parking areas, driveways, walking and bike paths, sidewalks, and emergency vehicle access lanes.
- Engineering or amending soils to improve infiltration properties.
- Ecologically enhancing stormwater treatment ponds.

XV. Promoting Stormwater Reuse

Project planners and design engineers should consider stormwater itself as an asset that can be used to reduce the impact of development projects on Duval County water resources. Rather than designing systems that allow stormwater to leave the site, often exacerbating downstream flooding and surface water degradation, LID promotes treatment and reuse of stormwater onsite. Stormwater reuse can offset potable water demands significantly, particularly when used for outdoor irrigation, which accounts for approximately 50% of residential households' water use in Florida. Specific stormwater reuse practices, such as the following, should be considered in site planning:

- Cisterns or rain barrels for collecting, storing, and using rainwater for irrigating lawns and landscape beds, irrigating green roofs, washing vehicles, etc.
- Stormwater reuse ponds with horizontal wells, typically used for irrigating lawns and landscape beds.
- Separate distribution pipes for non-potable stormwater reuse and reclaimed water systems.

XVI. Minimizing Site Disturbance

Mechanisms to reduce site disturbance before, during, and after construction are some of the most critical elements of an integrated and effective approach to LID stormwater planning. Opportunities to preserve and promote natural hydrologic functioning of a site are often lost as a result of conventional development practices such as non-selective site clearing, export of native soils, importing of fill, mass grading, and construction in sensitive areas using heavy machinery. Compaction of soils reduces the pore space available for storage and infiltration of stormwater. Some 80% of compaction occurs in the first pass of a vehicle across the soil, and compaction occurs to deeper depths in wetter soils. Clearing, grading, and construction measures that minimize site disturbance and promote LID function include:

- Minimizing clearing area.
- Clearing selectively.
- Using smaller and lighter construction equipment where possible.
- Keeping heavy equipment outside of the drip line of preserved trees.
- Minimizing grading and importing of fill (e.g., through use of stemwall construction).
- Keeping heavy equipment off of soils where infiltration-dependent stormwater practices will be used.

Duval County stormwater regulations provide maximum allowable compaction values when constructing certain LID practices, such as pervious pavements.

XVII. Detention with Biofiltration

Detention systems with biofiltration, or biofiltration systems, are shallow depressions with underdrains used as structural stormwater controls to capture and treat stormwater runoff (Figure 3.1-1). Within these systems, soils, mulch, and planted vegetation facilitate treatment and remove pollutants from the runoff. A biofiltration system can be implemented in a range of soil moisture conditions; however, optimal treatment capacity is affected by the length of the flow path through soil filtration media and by maintaining an aerobic soil profile. As is customary with LID practices, numerous control measures distributed throughout a catchment instead of a single large stormwater basin help facilitate treatment near the source. Although any one-treatment area may be small, the cumulative effect can be significant. Where infiltration is possible, this distributed approach better mimics predevelopment hydrologic conditions.

Examples, Applicability, General Feasibility, Physical Constraints, Design, etc.

XVIII. Shallow Bioretention

XIX. Rainwater Harvesting

XX. Pervious Pavements

Pervious pavement (also commonly referred to as *permeable pavement* and *porous pavement*) systems are structural stormwater controls that capture and temporarily store part or all of the water quality volume. Pervious pavement systems infiltrate and capture rainfall that falls on the surface at rates up to the surface infiltration rate, compared to impervious pavements where almost all direct rainfall becomes runoff. These systems infiltrate water below the surface, where water is typically allowed to exfiltrate into the surrounding parent soil. Under these circumstances, pervious pavement systems function as *retention systems*. Pervious pavement systems should be considered as part of a treatment train, with credit based on available storage volume and the ability of the system to readily recover the storage volume.

Many pervious pavement surface materials are available for different aesthetic considerations and costs. Pervious pavements surface materials can be divided into two groups: modular pavers and cast-in-place pavements. Figure 3.2-1 shows common pervious pavement surface materials. Profiles of modular block pervious pavements systems typically include three layers: surface layer, filter layer, and reservoir layer. Cast-in-place systems can either be incorporated into the three-layer design, a two-layer design (eliminating the filter layer), or be designed as a single continuous layer of the surface material directly over the parent soil, without a separate reservoir layer.

Examples, Applicability, General Feasibility, Physical Constraints, Design, etc.

XXI. Greenroof Stormwater Treatment Systems

A greenroof is a roof with vegetation planted on it. A greenroof stormwater treatment system is a vegetated roof with a cistern. The system can be used for stormwater pollution control, volume reduction, and peak flow reduction. In addition to vegetation, a greenroof has selected growth media and pollution-control media. Water which falls on a greenroof filters through the media to the roof drainage system. The filtrate from the greenroof discharges to a cistern that stores water. The filtrate water from the cistern is used first to irrigate the greenroof and then, if there is overflow, the water may be used for on-site bioswales or other green areas on the property. If approved with treatment, it may be used as gray water within a building. As a last option, it is discharged from the property. A cistern is located either above or below ground or, less frequently, within the structure or on the roof. It can be a surface pond. It must, however, have capacity to store roof filtrate to irrigate the greenroof.

A greenroof stormwater treatment system is ideal for just about any application where there is a suitable rooftop in area and structural capacity. Greenroofs can, however, be designed to be lightweight, thus making them viable for retrofits.

A greenroof stormwater treatment system intercepts rainfall where it is deposited and filters and holds the filtrate water, thus reducing roof runoff. The filtrate from rainfall and irrigation that is not held in the greenroof media is released to water storage before discharge. Drainage must be provided for excess water so there is minimal water storage in the media. A cistern or other water-storage device is used for irrigation to keep the plants on the greenroof alive and, if needed, for ground-level landscaping. The greenroof can be used on sloped roofs as well as “flat” roofs and consists of, first, a waterproof layer, typically a PVC or TPO membrane as these are inherent root barriers. Next, a protection layer, a drainage layer, a pollution-control layer, separation fabric, greenroof growth media, a cistern or water storage, a drip irrigation system, and plants are added. The greenroof filtrate contributes to the cistern as water not retained in the greenroof. The cistern only contributes to discharge when it is full. To minimize system overflows the cistern can be larger. Overflows can be discharged to other on-site stormwater controls, such as a bio-swale and other pervious areas or to common stormwater transport or other reuse systems.

A greenroof is typically classified into two types, an active greenroof or a passive greenroof. An active greenroof is one in which public access is allowed. A passive greenroof is one in which no public access is allowed. Passive greenroofs are also usually shallow, with a typical depth of 4 inches of growth media and pollution-control media, while active greenroofs are typically greater than 4 inches in depth. Active greenroofs often require more design detail, safety requirements, insurance, structural considerations (additional dead load due to the additional depth and live load due to people using it), and maintenance.

<u>Examples, Applicability, General Feasibility, Physical Constraints, Design, etc.</u>

XXII. Swale Section Design

XXIII. Roadway Design (width)

XXIV. Sidewalk Design

XXV. Safety Vehicle Access

XXVI. Right of Way – utilities, width, interceptor ponds

XXVII. Operation and Maintenance – Inspections and Enforcement (HOA issues)

XXVIII. Incentives – Stormwater Fee / Density

XXIX. References

XXX. Web Links